

## CLAIMS

1. An image pickup apparatus comprising:

a first lens group for performing a magnification varying operation;

a second lens group for correcting a movement of a focal plane during a movement of said first lens group;

driving means for respectively driving said first lens group and said second lens group;

storage means for storing, according to a subject distance, an in-focus position of said second lens group relative to a position of said first lens group;

predicting means for predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation; and

control means for performing correction of focus by calculating a standard moving speed of said second lens group for correcting a movement of the focal plane with respect to the predicted destination position, according to information stored in said storage means, and driving said second lens group at the standard moving speed.

2. An image pickup apparatus comprising:

a first lens group for performing a magnification varying operation;

a second lens group for correcting a movement of a focal plane during a movement of said first lens group;

driving means for respectively driving said first lens group and said second lens group;

storage means for storing, according to a subject distance, an in-focus position of said second lens group relative to a position of said first lens group;

focus detecting means for outputting a focus signal;

predicting means for predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation; and

control means for calculating a standard moving speed of said second lens group for correcting a movement of the focal plane with respect to the predicted destination position, according to information stored in said storage means, and driving said second lens group while varying the standard moving speed according to an increase or decrease in the focus signal.

3. An image pickup apparatus comprising:

a first lens group for performing a magnification varying operation;

a second lens group for correcting a movement of a focal plane during a movement of said first lens group;

driving means for respectively driving said first lens group and said second lens group;

storage means for storing, according to a subject distance, an in-focus position of said second lens group

relative to a position of said first lens group;

predicting means for predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation;

calculating means for finding a correction position of said second lens group for correcting a movement of the focal plane with respect to the destination position, according to information stored in said storage means; and

control means for controlling a position of said second lens group so that said second lens group reaches the correction position after the predetermined time period.

4. An image pickup apparatus comprising:

a first lens group for performing a magnification varying operation;

a second lens group for correcting a movement of a focal plane during a movement of said first lens group;

driving means for respectively driving said first lens group and said second lens group;

storage means for storing, according to a subject distance, an in-focus position of said second lens group relative to a position of said first lens group;

focus detecting means for outputting a focus signal;

predicting means for predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying

operation;

calculating means for finding a correction position of said second lens group for correcting a movement of the focal plane with respect to the destination position, according to information stored in said storage means;

correction position changing means for changing the correction position according to an increase or decrease in the focus signal; and

control means for controlling a position of said second lens group so that said second lens group reaches the changed correction position after the predetermined time period.

5. An image pickup apparatus according to one of claims 1 to 4, wherein the predetermined time period is equivalent to one vertical synchronizing period.

6. An image pickup apparatus according to one of claims 1 to 4, wherein a stepping motor is used as said driving means.

7. An image pickup apparatus according to one of claims 1 to 4, wherein a linear motor is used as said driving means.

8. An image pickup method of picking up an image by using a first lens group for performing a magnification varying operation, a second lens group for correcting a

movement of a focal plane during a movement of said first lens group, driving means for respectively driving said first lens group and said second lens group, storage means for storing, according to a subject distance, an in-focus position of said second lens group relative to a position of said first lens group, said image pickup method comprising the steps of:

predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation; and

calculating a standard moving speed of said second lens group for correcting a movement of the focal plane with respect to the predicted destination position, according to information stored in said storage means, and driving said second lens group at the standard moving speed.

9. An image pickup method of picking up an image by using a first lens group for performing a magnification varying operation, a second lens group for correcting a movement of a focal plane during a movement of said first lens group, driving means for respectively driving said first lens group and said second lens group, storage means for storing, according to a subject distance, an in-focus position of said second lens group relative to a position of said first lens group, and extracting means for extracting a focus signal from a signal of an image picked up by image pickup means, said image pickup method comprising the steps of:

predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation; and

calculating a standard moving speed of said second lens group for correcting a movement of the focal plane with respect to the predicted destination position, according to information stored in said storage means, and driving said second lens group while varying the standard moving speed according to an increase or decrease in the focus signal.

10. An image pickup method of picking up an image by using a first lens group for performing a magnification varying operation, a second lens group for correcting a movement of a focal plane during a movement of said first lens group, driving means for respectively driving said first lens group and said second lens group, storage means for storing, according to a subject distance, an in-focus position of said second lens group relative to a position of said first lens group, said image pickup method comprising the steps of:

predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation;

finding a correction position of said second lens group for correcting a movement of the focal plane with respect to the destination position, according to information stored in said storage means; and

controlling a position of said second lens group

so that said second lens group reaches the correction position after the predetermined time period.

11. An image pickup method of picking up an image by using a first lens group for performing a magnification varying operation, a second lens group for correcting a movement of a focal plane during a movement of said first lens group, driving means for respectively driving said first lens group and said second lens group, storage means for storing, according to a subject distance, an in-focus position of said second lens group relative to a position of said first lens group, and extracting means for extracting a focus signal from a signal of an image picked up by image pickup means, said image pickup method comprising the steps of:

predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation;

finding a correction position of said second lens group for correcting a movement of the focal plane with respect to the destination position, according to information stored in said storage means;

changing the correction position according to an increase or decrease in the focus signal; and

controlling a position of said second lens group so that said second lens group reaches the changed correction position after the predetermined time period.

12. An image pickup method according to one of claims 8 to 11, wherein the predetermined time period is equivalent to one vertical synchronizing period.

13. An image pickup apparatus according to one of claims 8 to 11, wherein a stepping motor is used as said driving means.

14. An image pickup apparatus according to one of claims 8 to 11, wherein a linear motor is used as said driving means.

15. A lens control apparatus comprising:  
a movable part which is movable along an optical axis for performing focus adjustment;  
an actuator for driving said movable part;  
position-of-movable-part detecting means for detecting a position of said movable part;  
focus control means for determining a state of focus and supplying a driving signal which causes said movable part to move toward an in-focus position, according to the determined state of focus; and  
position control means for performing position control of said movable part via said actuator by updating the driving signal by a plurality of times during a predetermined time period so that an average moving speed of said movable part during the predetermined time period becomes a predetermined speed.



16. A lens control apparatus according to claim 15, wherein said actuator is a linear motor, and said position control means updates a target position  $n$  times during the predetermined time period by an amount of movement,  $s/n$ , at a time with respect to an amount of movement,  $s$ , by which said movable part moves at the predetermined speed, and uses a driving signal corresponding to the updated target position as the driving signal to be supplied to said linear motor by said focus control means.

17. An image pickup apparatus comprising:

image pickup means including a lens and an image pickup element;

an actuator for moving a movable part along an optical axis defined by the lens and the image pickup element, said movable part being either one of the lens and the image pickup element;

position-of-movable-part detecting means for detecting a position of said movable part;

extracting means for extracting a focus voltage signal from an output signal of said image pickup means; and

focus control means for determining whether a state of focus is an in-focus state, according to a signal level of the focus voltage signal extracted by said extracting means, and supplying a driving signal which causes said movable part to move toward an in-focus position, to said actuator according to the determined state of focus,

said focus control means including:

first control means for calculating a target position to which said movable part is made to move, on a first control cycle according to the signal level of the focus voltage signal extracted by said extracting means; and

second control means for updating the driving signal to be supplied to said actuator, on a second control cycle,

said second control means executing updating of the driving signal on the second control cycle so that an average moving speed at which said movable part continues to move until said movable part reaches the target position calculated by said first control means becomes a predetermined speed, as well as so that said movable part gradually approaches the target position until said movable part reaches the target position.

18. An image pickup apparatus according to claim 17, wherein said actuator is a linear motor, and said second control means includes selecting means for selecting, according to a positional difference between the target position calculated by said first control means and a current position of said movable part, control for forcedly updating the driving signal to be supplied to said linear motor with a driving signal corresponding to the target position or control for updating the driving signal to be supplied to said linear motor with a driving signal which causes said movable part to gradually approach the target

position.

19. An image pickup apparatus according to claim 15 or 17, wherein the predetermined speed varies according to the signal level of the focus voltage signal or the determined state of focus.

20. An image pickup apparatus comprising:

a first lens group for performing a magnification varying operation;

a second lens group and an image pickup element either one of which constitutes a movable part for correcting a movement of a focal plane during a movement of said first lens group;

position-of-movable-part detecting means for detecting a position of said movable part;

driving means for driving said movable part by supplying a driving signal to an actuator for moving said movable part along an optical axis;

storage means for storing, according to a subject distance, an in-focus position of said movable part relative to a position of said first lens group;

predicting means for predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation;

calculating means for calculating a correction position of said movable part for correcting a movement of

the focal plane with respect to the destination position predicted by said predicting means according to information stored in said storage means; and

position control means for performing position control of said movable part so that, after the predetermined time period, said movable part reaches the correction position calculated by said calculating means,

said position control means controlling a movement of said movable part so that an average moving speed of said movable part during the predetermined time period becomes a predetermined speed.

21. An image pickup apparatus according to claim 20, wherein the predetermined speed is equivalent to a speed at which said movable part moves past a positional difference between a current position of said movable part and the correction position calculated by said calculating means, within the predetermined time period.

22. An image pickup apparatus comprising:

a first lens group for performing a magnification varying operation;

first driving means for moving said first lens group;

a second lens group and an image pickup element either one of which constitutes a movable part for correcting a movement of a focal plane during a movement of said first lens group;

position-of-movable-part detecting means for detecting a position of said movable part;

second driving means for driving said movable part by supplying a driving signal to an actuator for moving said movable part along an optical axis;

storage means for storing, according to a subject distance, an in-focus position of said movable part relative to a position of said first lens group;

predicting means for predicting a destination position to be reached by said first lens group after a predetermined time period, during the magnification varying operation;

calculating means for calculating a correction position of said movable part for correcting a movement of the focal plane with respect to the destination position predicted by said predicting means according to information stored in said storage means; and

position control means for performing position control of said movable part so that, after the predetermined time period, said movable part reaches the correction position calculated by said calculating means,

a moving speed of said first lens group being controlled so that a position to be reached by said first lens group after the predetermined time period becomes coincident with an end position of a movable range of said first lens group if the destination position predicted by said predicting means exceeds the end position.

23. An image pickup apparatus comprising:

a first lens group for performing a magnification  
varying operation;

first driving means for moving said first lens  
group;

a second lens group and an image pickup element  
either one of which constitutes a movable part for  
correcting a movement of a focal plane during a movement of  
said first lens group;

position-of-movable-part detecting means for  
detecting a position of said movable part;

second driving means for driving said movable part  
by supplying a driving signal to an actuator for moving said  
movable part along an optical axis;

storage means for storing, according to a subject  
distance, an in-focus position of said movable part relative  
to a position of said first lens group; and

control means for performing position control of  
said movable part for correcting a movement of the focal  
plane due to a variation in position of said first lens  
group during the magnification varying operation, according  
to information stored in said storage means,

said movable part being forcedly moved to an in-  
focus position relative to a stop position of said first  
lens group at the instant when the magnification varying  
operation stops.

24. An image pickup apparatus comprising:

a first lens group for performing a magnification varying operation;

a second lens group and an image pickup element either one of which constitutes a movable part for performing focus adjustment as well as correcting a movement of a focal plane during the magnification varying operation;

first control means for performing position control of said first lens group to move said first lens group along an optical axis; and

second control means for performing position control of said movable part to move said movable part along the optical axis,

a control cycle of said second control means being made shorter than a control cycle of said first control means at least if a position of said first lens group is present in a predetermined area.

25. An image pickup apparatus according to claim 24, wherein the predetermined area is a long focal length area on a telephoto side.

26. A method of controlling an image pickup apparatus, comprising the steps of:

causing an actuator to move a movable part along an optical axis defined by a lens and an image pickup element, said movable part being either one of the lens and the image pickup element;

determining a state of focus; and

performing position control of said movable part so that said movable part moves toward an in-focus position, according to the determined state of focus,

a driving signal for moving said movable part being given to said actuator while being updated by a plurality of times during a predetermined time period so that an average moving speed of said movable part during the predetermined time period becomes a predetermined speed.

27. A method of controlling an image pickup apparatus according to claim 26, wherein said actuator is a linear motor, and the driving signal which is given to said linear motor while a target position is being updated  $n$  times during the predetermined time period by an amount of movement,  $s/n$ , at a time with respect to an amount of movement,  $s$ , by which said movable part moves at the predetermined speed is used as a driving signal corresponding to the updated target position.

28. A method of controlling an image pickup apparatus, comprising the steps of:

causing an actuator to move a movable part along an optical axis defined by a lens and an image pickup element, said movable part being either one of the lens and the image pickup element;

determining whether a state of focus is an in-focus state, according to a signal level of a focus voltage signal obtained from an output signal of the image pickup



element; and

performing position control of said movable part so that said movable part moves toward an in-focus position, according to the determined state of focus,

a target position to which said movable part is made to move according to the signal level of the focus voltage signal being calculated on a first control cycle, and the driving signal to be given to said actuator being updated on a second control cycle so that an average moving speed at which said movable part continues to move until said movable part reaches the calculated target position becomes a predetermined speed, as well as so that said movable part gradually approaches the target position until said movable part reaches the target position.

29. A method of controlling an image pickup apparatus according to claim 28, wherein said actuator is a linear motor, said method further comprising the step of selecting, according to a positional difference between the target position calculated on the first control cycle and a current position of said movable part, control for forcedly updating the driving signal to be given to said linear motor with a driving signal corresponding to the target position or control for updating the driving signal to be given to said linear motor with a driving signal which causes said movable part to gradually approach the target position.

30. A method of controlling an image pickup apparatus

according to claim 26 or 28, wherein the predetermined speed varies according to the signal level of the focus voltage signal or the determined state of focus.

31. A method of controlling an image pickup apparatus, comprising the steps of:

causing an actuator to move either one of a second lens group and an image pickup element, which constitutes a movable part for correcting a movement of a focal plane during a movement of a first lens group for performing a magnification varying operation, along an optical axis defined by said second lens group and said image pickup element;

predicting a destination position to be reached by said first lens group after a predetermined time period during the magnification varying operation; and

calculating a correction position of said movable part for correcting a movement of the focal plane with respect to the predicted destination position of said first lens group, by means of a memory which stores an in-focus position of said movable part relative to a position of said first lens group according to a subject distance, and performing position control of said movable part so that, after the predetermined time period, said movable part reaches the calculated correction position,

a movement of said movable part being controlled so that an average moving speed of said movable part during the predetermined time period becomes a predetermined speed.

32. A method of controlling an image pickup apparatus according to claim 31, wherein the predetermined speed is equivalent to a speed at which said movable part moves past a positional difference between a current position of said movable part and the correction position within the predetermined time period.

33. A method of controlling an image pickup apparatus, comprising the steps of:

causing an actuator to move either one of a second lens group and an image pickup element, which constitutes a movable part for correcting a movement of a focal plane during a movement of a first lens group for performing a magnification varying operation, along an optical axis defined by said second lens group and said image pickup element;

predicting a destination position to be reached by said first lens group after a predetermined time period during the magnification varying operation; and

calculating a correction position of said movable part for correcting a movement of the focal plane with respect to the predicted destination position of said first lens group, by means of a memory which stores an in-focus position of said movable part relative to a position of said first lens group according to a subject distance, and performing position control of said movable part so that, after the predetermined time period, said movable part reaches the calculated correction position,

a moving speed of said first lens group being controlled so that a position to be reached by said first lens group after the predetermined time period becomes coincident with an end position of a movable range of said first lens group if the destination position predicted by said predicting means exceeds the end position.

34. A method of controlling an image pickup apparatus, comprising the steps of:

causing an actuator to move either one of a second lens group and an image pickup element, which constitutes a movable part for correcting a movement of a focal plane during a movement of a first lens group for performing a magnification varying operation, along an optical axis defined by said second lens group and said image pickup element;

predicting a destination position to be reached by said first lens group after a predetermined time period during the magnification varying operation; and

calculating a correction position of said movable part for correcting a movement of the focal plane with respect to the predicted destination position of said first lens group, by means of a memory which stores an in-focus position of said movable part relative to a position of said first lens group according to a subject distance, and performing position control of said movable part so that, after the predetermined time period, said movable part reaches the calculated correction position,

said movable part being forcedly moved to an in-focus position relative to a stop position of said first lens group at the instant when the magnification varying operation stops.

35. A method of controlling an image pickup apparatus which performs position control of a first lens group for performing a magnification varying operation and either one of a second lens group and an image pickup element, which constitutes a movable part for performing focus adjustment as well as correcting a movement of a focal plane during the magnification varying operation, so that said first lens group and said movable part are respectively moved along an optical axis, a control cycle of said movable part being made shorter than a control cycle of said first lens group at least if a position of said first lens group is present in a predetermined area.

36. A method of controlling an image pickup apparatus according to claim 35, wherein the predetermined area is a long focal length area on a telephoto side.

37. A lens control apparatus comprising:  
a movable part which is movable along an optical axis for performing focus adjustment;  
an actuator for driving said movable part;  
position-of-movable-part detecting means for detecting a position of said movable part;

focus control means for determining a state of focus and supplying to said actuator a driving signal which causes said movable part to move toward an in-focus position, according to the determined state of focus; and

position control means for performing position control of said movable part via said actuator by updating the driving signal by a plurality of times during a predetermined time period so that an average moving speed of said movable part during the predetermined time period becomes a predetermined speed.

38. A lens control apparatus according to claim 38, wherein said actuator is a linear motor.

39. A lens control apparatus according to claim 37, further comprising image pickup means, said focus control means determining the state of focus by extracting a predetermined focus signal which varies according to the state of focus, from a picked-up image signal outputted from said image pickup means.

40. A lens control apparatus according to claim 37, wherein said position control means updates a target position  $n$  times during the predetermined time period by an amount of movement,  $s/n$ , at a time with respect to an amount of movement,  $s$ , by which said movable part moves at the predetermined speed, and uses a driving signal corresponding to the updated target position as the driving signal to be

